On the supposed Rarity, Nomenclature, Structure, Affinities, and Source of the large human Fluke (*Distoma crassum*, Busk).

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[Read February 10, 1875.]

It will be within the recollection of some of the senior members of the Society that about thirty years ago Professor Busk discovered fourteen large flukes in the duodenum of a Lascar who died at the Seamen's Hospital. Not only were these parasites correctly regarded as new to science at the time, but, what is more remarkable, no second instance of the occurrence of this entozoon has since been placed on record. To be sure, there are several human parasites that have only once been observed; but these instances refer, for the most part, to minute helminths, such as the dwarf tapeworm (*Tænia nana*) and the almost microscopic fluke known as the *Distoma heterophyes*. It is therefore, I repeat, rather strange that during the interval elapsing from the winter of 1843 to the spring of 1874, this comparatively large Trematode should not have been again encountered—and the more so, since our professional friends stationed in India, and throughout the East generally, have of late years shown great activity in searching for entozoa.

In reference to the assumed rarity of the parasite, it will not be out of place to refer to other instances of a similar kind affecting animal hosts. I will adduce only two cases, in both of which the entozoa, though now known to be abundant, were for a long time overlooked, and consequently supposed to be extremely rare.

In the year 1858 I discovered a small fluke in the liver-ducts of an American red fox (*Canis fulvus*) that had died at the Zoological Society's Gardens; but no second instance of the occurrence of this parasite (*Distoma conjunctum*) was recorded until the year 1871, when Dr. Lewis found great numbers infesting the pariah dogs of India. The second and far more striking instance of verification after a long interval of time is that of *Stephanurus dentatus*. This rather large Nematode was originally discovered by Natterer at Barra do Rio Negro, Brazil, in 1834. He found it infesting a Chinese variety of the common hog. It was shortly afterwards described and figured by Diesing; and nothing could exceed the accuracy of the description given by the Vienna hel-

minithologist, who at the time was still in possession of his eyesight. Here, again, however, no second instance of the occurrence of the "parasite" was made known until thirty-five years had elapsed. In the year 1869 Professor Verrill described what he very naturally supposed to be a new entozoon infesting the hogs of the United States. He called the species *Sclerostoma pinguicola*. Specimens of these worms, however, having been forwarded to me by Professor Fletcher, of Indianapolis, I at once saw that Verrill's *Sclerostomata* were the *Stephanuri* of Diesing and Natterer. Subsequently also I detected this self-same entozoon in a batch of parasites sent from Australia to the Microscopical Society of London for the purpose of identification. It thus appears, from the case of *Stephanurus*, that a parasite capable of producing serious mischief and even death amongst well-known animals may evade rediscovery for a very long period of time, and this, too, notwithstanding the ever-increasing number of natural-history observers. Of more importance, also, is the consideration that many a species, hitherto assumed to be extremely rare and local, may turn out to be both numerically abundant and of wide geographical distribution. As will be seen in the sequel, the latter part of this inference applies with some force to the parasite now before us; and I should not be at all surprised if its supposed rarity were eventually proven to be without foundation in fact.

For an opportunity of securing fresh examples of the *Distoma crassum* I stand indebted to Dr. George Johnson, F.R.S., who in the spring of last year recommended two of his patients—a missionary and his wife—to call on me in order that I might have an opportunity of examining and identifying the parasites that were occasionally escaping their bearers *per vias naturales*. I should mention that Dr. Johnson readily recognized the trematode character of the helminths, and that he advised accordingly. Reserving purely professional details for publication elsewhere, I have to state that from the missionary and his partner I learned that they had been resident in China for about four years. During that time they had together freely partaken of fresh vegetables in the form of salad, and also occasionally of oysters, but more particularly of fish, which, in common with the oysters, abound in the neighbourhood of Ningpo. From their statements it appeared to me that to one or other of these sources we must look for an explanation of the fact of their concurrent infection. Fluke larvæ, as we know, abound in mollusks and fish; but whether any of the

forms hitherto found in oysters or in fish have any genetic relation to the flukes of man, is a question that cannot very well be settled in the absence of direct experimental proof. I should add that it was not until after their visit to the interior of the country, some 130 miles distant from Ningpo, that the symptoms which Dr. Johnson and myself consider to have been due to the presence of the parasites made their appearance. Whilst in the country they freely partook of freshwater fish, and on one occasion they received a quantity of oysters that had been sent up from Ningpo. The missionary assured me that the fish were always thoroughly well cooked.

From the size and almost leathery texture of the two flukes which were in the first instance submitted to my notice, I at once recognized the species; but as they were spirit-specimens, I requested that if any more examples were obtained they should be sent to me in the fresh state. Fortunately others were brought in a few days, when, from an examination conducted whilst they were still fresh, I was able to make out several details of structure which had hitherto escaped notice. Altogether I secured seven specimens, three of them being in a mutilated condition. In what way these mutilations (as shown by the dried specimens) occurred I have not been able to make out, either by personal observation or by questioning the bearers. Two of the parasites look as though their bodies had been carefully excised near their centre. Such new facts as I have gleaned were derived from two comparatively small specimens, one of which, in the dried state, has since been deposited in the anatomical department of the University Museum at Oxford. I may add that I took the earliest opportunity of bringing some of the specimens under Mr. Busk's attention, when he at once recognized them as referable to the species he had so long ago discovered.

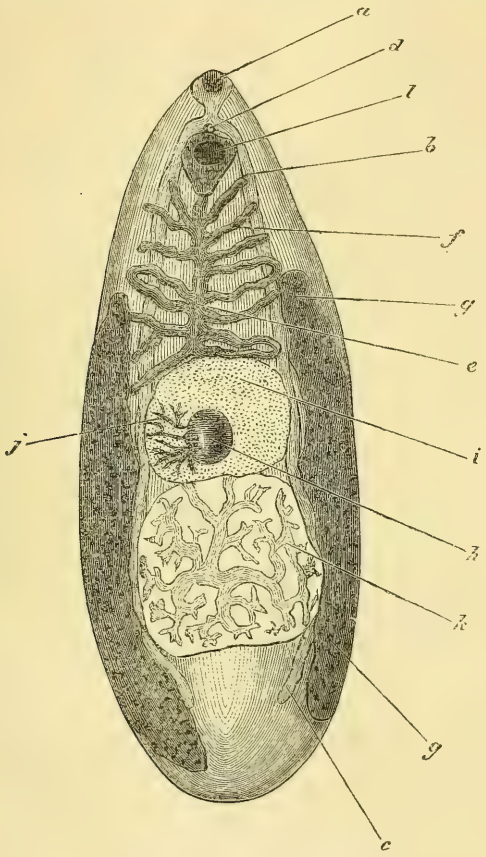
Of the fourteen original specimens found by Mr. Busk, several have been lost. The one that he himself gave me I handed over to Professor Leuckart; and it is figured in his work (Die mensch. Par. i. s. 586). A second is preserved in the Museum attached to the Middlesex Hospital; and a third is contained in the Museum of the Royal College of Surgeons. This last-named specimen is the best of the original set. It supplied me with the few details of structure figured in outline in my 'Introductory Treatise' (fig. 42, p. 193), published in 1864; and it also in part formed the basis of the description of the species communicated

to this Society in June 1859 (Synopsis of the Distomidæ, p. 5, Proceedings, vol. v.). The late Dr. Lankester, it is true, in his English edition of Küchenmeister's work on Parasites, was the first to give a distinctive title to this entozoon (*Distoma Buskii*); but as the discoverer objected to this nomenclature, and as Dr. Lankester's proposed terms were unaccompanied by any original description, I requested Mr. Busk to suggest a new name for the worm, which he accordingly characterized as above. As I subsequently pointed out, Von Siebold had already employed the compound title *Distoma crassum* to designate a small fluke infesting the House-Martin (*Hirundo urbica*); but for reasons similar to those which contributed to set aside Dr. Lankester's nomenclature, the title adopted in my synopsis at length came to be recognized by Leuckart and other well-known helminthologists. Before this recognition took place, however, Dr. Weinland, of Frankfort, had so far accepted Lankester's nomenclature as to call the species *Dicrocœlium Buskii*. In my judgment there were no sufficient grounds for placing the parasite in Dujardin's unsatisfactory genus. Be that as it may, I have only further to observe that in addition to the original specimens above particularized, two others are preserved in the Museum at King's College. Thus probably only five out of the fourteen specimens are still in existence; and such being the case, I have thought it worth while to collect and record these few particulars.

The earliest literary notice of the entozoon appeared in Dr. Budd's classical treatise 'On Diseases of the Liver;' and in it the author correctly stated, from data supplied by Dr. Busk, that these human flukes were "much thicker and larger than those of the sheep," being, it is added, from "an inch and a half to near three inches in length." The longest of my recent specimens, however, scarcely exceeds two inches, whilst the smallest and most perfect (the one at Oxford) measures less than an inch from head to tail. The greatest width of my broadest specimen is little more than half an inch, or $\frac{9}{16}''$. None of the twelve examples that I have examined approach the length of three inches; but Mr. Busk assured me that, judging from his recollection, some of his specimens were even longer than that. I fear, nevertheless, that the estimate given in my Synopsis is somewhat exaggerated; at all events it is so for average specimens.

The new anatomical facts made out by me bear reference principally to the reproductive apparatus. What else I have

observed is, for the most part, confirmatory of the statements made by Mr. Busk. In particular, his brief account of the position and character of the digestive organs was not only confirmed by my earlier examinations, but is now reverified. In the representation given in my 'Introduction' I showed in dotted outline two large organs which I supposed to be the testes. I distinctly observed radiating lines proceeding from each of these masses; but I could not discover the slightest trace of any limiting border to



Distoma crassum, Busk.

a, oral sucker; *b*, digestive tube; *c*, cæcal end of the same; *d*, reproductive papilla; *e*, central uterine duct; *f*, lateral process or fold of the same; *g*, vitelligene gland; *h*, diverticulum; *i*, ovary; *j*, probable shell-gland; *k*, testis and seminal ducts. Magnified twice the natural size.

either organ. I have now found in their place two irregularly spherical and flattened masses with clearly defined limits (*i*, *k*). I entertain no doubt as to the testicular character of the lower organ (*k*). In the outline drawing I further indicated the presence of a third and much smaller globular mass, which I termed the ovary; and this organ was seen with remarkable distinctness in most of my recent specimens (*h*). The radiating, broad and branching seminal ducts were in all cases beautifully distinct, forming the most attractive feature of the parasite's organization (*k*). Connected with the supposed ovary were a number of small but very conspicuous tubes, which stood out as if they formed a special organ (*j*), whose common ducts emptied themselves into, or were connected with, the ovary. In whatever way we may interpret its character, nothing could exceed its distinctness in the fresh state; and it may still be seen with clearness in one or two of the dried specimens. The supposed upper testis (*i*) displayed no radiating seminal tubes; consequently I now conclude that it is the ovary, whilst the small, black, spherical body lying immediately in front of it is what Von Siebold would call the internal seminal vesicle (*h*). It is probably a diverticulum formed at the junction of the ovarian and vitelligene ducts, whilst the singular branched tubes in all likelihood represent a special shell-gland (*j*). I made out the female reproductive organs with somewhat more completeness. In the outline drawing already referred to, I gave a diagram of the probable position of the uterine folds, reducing the organ to the simplest condition. The conjecture was right. In the fresh specimens, I found the uterus to comprise a large number of unevenly folded tubes, which apparently proceed laterally from either side of a large median duct (*e*). This duct could be distinctly traced to its outlet in the reproductive papilla, which, as usual in true Distomes, is placed in the middle line, immediately above the ventral sucker. In my examination of Mr. Busk's original specimens I could not find the slightest trace of vitelligene organs; but in the present set of fresh examples I not only obtained proof that these organs were largely developed, but that their limitations could be fixed with accuracy (*g g*). They consisted of two large elongated masses, one on either side of the body, occupying about two thirds of the entire length of the parasite. Their yelk-vesicles were distinctly seen; but the main efferent canals were only here and there traceable. Clearly the position and character of the yelk-forming glands of the large human

fluke are quite unlike those of any of its congeners. This fluke is a remarkably fine species, and, when viewed in the fresh state with a powerful pocket-lens, presents a most striking appearance. I did not observe any cutaneous spines. I found the eggs to present an average long diameter of about $\frac{1}{200}''$, by $\frac{1}{330}''$ in breadth. They are therefore somewhat smaller than those of the common fluke. In the specimen preserved in the Hunterian Museum there was evidence of the presence of an excretory outlet at the caudal extremity; but in the present examples I did not succeed in finding any trace of the water-vascular system. I have no doubt, however, that it exists in the usual form.

As regards the affinities of *Distoma crassum*, it is clear that this Trematode has little in common either with the liver-fluke of cattle and sheep (*Fasciola hepatica*), or the still larger species obtained by me from the giraffe (*Fasciola gigantea*). The simple character of the digestive tubes obviously connects it more closely with the lancet-shaped fluke (*Distoma lanceolatum*—the last-named parasite being also an occasional resident in the human liver, where its presence has been known to contribute to the production of a fatal result. Here, I may remark that it has struck me as not a little singular that most of the flukes which take up their residence in the liver exhibit a branched arrangement of the digestive tubes; and but for the circumstance that the *Distoma lanceolatum* forms a notable exception, I should have been disposed to consider that a branched state of the alimentary apparatus was of necessity associated with this special habitation. At all events it is interesting to observe that no species of intestinal fluke is known to display this complex form of digestive apparatus, the species before us forming no exception to the rule. In the fluke (*Campula oblonga*) that I discovered in the liver of a porpoise, there were traces of this tendency of the tubes to branch, whilst an extreme development of this sort is seen in the fluke which proves so destructive to elephants (*Fasciola Jacksoni*). Taking the genus *Distoma* as representing central type forms of the Trematoda, I look upon the flukes that have dendritically branched cæca as aberrant types; and it is just these particular forms that show the strongest zoological affinity with the Planarians, not only by virtue of the anatomical peculiarity in question, but also as regards their habits. If the contents of the cæca be examined, epithelium and blood-corpuscles derived from their bearers will be found amongst the *débris*; and it is well

known that the Planarians, especially the terrestrial forms, are carnivorous in their habits. In proof of this view of their habits, Mr. Moseley has recently brought forward additional evidence in his elaborate memoir "On the Land-Planarians of Ceylon" (Phil. Trans. 1874). The significance of these facts in relation to any theory of descent must not be lost sight of. Without dwelling upon that point, however, I pass on to observe that our *Distoma crassum*, both as regards the restricted character of the vitelligene glands and the simple form of the testis, and also in respect of the unbranched state of the digestive cæca, shows a close adherence to the central Distome type, in which, as we have seen, Mr. Busk originally placed it. If there be any structural departures from the common type, they are connected with the testes. I believe that the two organs are here merged in one large compound gland. Amongst Trematodes, as Von Siebold long ago pointed out, such an arrangement occasionally exists. Further observations are necessary to clear up this and one or two other points of structure which I strove in vain to make out accurately. Nevertheless, fragmentary as the present data are, it is something not only to have stumbled upon a second and a third instance of the occurrence of this rare entozoon in the human body, but also to have been enabled to confirm the truth of almost all that had been previously conjectured respecting its structure, and at the same time also to have acquired new facts of sufficient importance to fix the affinities with precision.

Here my paper, as regards new facts, virtually closes; but so much interest naturally attaches itself to the question of the origin and early stages of growth of the parasite, that I feel our time will not be wasted if we take into consideration some of the more important and recently ascertained facts that tend to throw light upon the subject.

At the outset I hinted that the Ningpo oysters may have played the *rôle* of intermediary bearers in the case before us; and as tending in some measure to strengthen that notion, it should be borne in mind that Mr. Busk's original fluke-bearer came from eastern parts. It is not improbable, therefore, that the Lascar may have partaken of the same species, either of fish or of shell-fish, that the missionary and his wife partook of. Be that as it may, the frequency of the occurrence of Trematodes and their larvæ in marine mollusks is well known; though until comparatively lately it was not so well understood that the singular double-tailed redia or organized germ-sac, known as *Bucephalus*,

was an occupant of saltwater as well as freshwater mollusks. The original specimens which gave origin to the genus were found by Von Baer in the freshwater mussel; but since the publication of his memoir (Nova Acta, xiii.), the same, or at all events similar forms of larvæ have been encountered in a variety of mollusks. Up to the present time *Bucephali* have been found in *Unio pictorum*, *Anodonta cellensis*, and *A. anatina*, *Cardium edule* and *C. rusticum*, *Ostrea edulis*, *Planorbis marginata*, and in one or more species of *Paludina*. According to Woodward, several species of oyster are sold in the Indian and Chinese markets; so that there may be some difficulty in determining the particular species to which the Ningpo oysters should be referred.

Now that I am thus incidentally led to speak of the *Bucephali*, I may mention that on the 7th of last October several examples of free rediæ were exhibited by Mr. Badcock at a Meeting of the Royal Microscopical Society, on which occasion Mr. Charles Stewart, Mr. White, Mr. Slack, and other well-known microscopists communicated observations. I understood that Professors Huxley and Reay Greene determined the bucephaloid character of these cercarians from specimens that were separately brought under their notice.

The recent contribution by M. A. Giard on the encystation of *Bucephalus Haimeanus* contains important additions to our knowledge, whilst at the same time it affords a useful summary of the facts previously supplied by Von Baer, Steenstrup, Von Siebold, Claparède, and Lacaze-Duthiers. Dr. Pagenstecher's memoir appears to have escaped Giard's notice; yet the Heidelberg savant was one of the first to point out that the highly contractile double tail-like appendages of this remarkable germ-sac were capable of developing into new germ-sacs, which latter, in their turn, developed within them fresh *Bucephali*. M. Giard shows that *Bucephalus Haimeanus* encysts itself in the viscera of the garfish (*Belone vulgaris*), especially in the peritoneum, liver, and genital glands (Comptes Rendus, Aug. 17, and Ann. Nat. Hist. for Nov. 1874). The predilection of *Bucephali* for the reproductive territory, so to speak, causes sterility in their molluscan intermediary bearers. This was pointed out by Claparède, who also found rediæ of this kind attached to Medusæ; but since there was no evidence to show that this attachment presented the semiparasitic character of a commensal or fellow-boarder, it is fair to suppose that the connexion was merely accidental. The free *Bucephali* found by Claparède off the coast of Normandy did not

differ materially from those obtained by Lacaze-Duthiers from the Mediterranean.

From all the facts at present before us M. Giard argues that it is most probable the *Bucephali* of the garfishes attain sexual maturity as *Gasterostomata* in sharks and dogfishes, and perhaps also in certain large species of *Gadidæ*, which feed on the garfishes when they frequent the shore for the purpose of spawning. In drawing this conclusion, M. Giard has probably been much influenced by the opinion of Von Siebold, who long ago suggested, but of course could afford no experimental proof, that *Bucephalus polymorphus* was the larval representative of *Gasterostoma fimbriatum*.

If we accept these views, as I believe we must, it becomes extremely unlikely that the *Bucephali* should in any way be concerned in causing the infection of our missionary and his wife; nevertheless there remains the probability that the human bearers in question swallowed other kinds of Trematode larvæ when they consumed the Ningpo oysters. Moreover, if it should happen that none of the other larvæ occurring in oysters are capable of developing into flukes in the human territory, it yet remains highly probable that some one or other of the various encysted (and therefore sexually immature) Trematodes known to infest marine fishes will turn out to be the representative of our *Distoma crassum*. In this connexion we must not forget that Leuckart has pointed to the flesh of Salmonidæ as the probable source of human *Bothriocephali*; and there is some likelihood that salt-water fishes, if not actually the primary, may become (after the manner explained by M. Giard) the secondary intermediary bearers of fluke-larvæ.

On the whole, I am still inclined to look to the Ningpo oysters, or to some other of the various species of marine shell-fish sold in eastern markets, as the direct source of *Distoma crassum*; for, in addition to the bucephaloid cercarians, we have abundant evidence of the existence of other and more highly developed fluke-larvæ in bivalve mollusks. So far back as the year 1841 Mr. Garner, F.L.S., in his paper on the Lamellibranchiate Conchifera (Zool. Trans. vol. ii.) referred to a species of *Distoma* in the freshwater Mussel; and he subsequently attempted to prove the parasitic origin of pearls from a similar source (Brit. Assoc. Rep. 1862). I had an opportunity of examining some of these *Distomata*, and satisfied myself that they were only sexually immature forms awaiting their final passive transference to the intestine of

some vertebrate host. To be sure, the ultimate bearer need not be the human species; yet, on the other hand, such a contingency is by no means improbable. Here I would remark that we have very little knowledge of the parasites which take up their abode in the viscera of savages. This ignorance results partly from the fact that these untutored races, as proved by the statements of Kaschin and others, actually suffer much less from the presence of intestinal worms than their civilized congeners do, and partly because no one, so far as I am aware, has cared to institute the necessary inquiries in a methodical way. I strongly suspect that several of the human parasites which we now consider to be rare would be found to be abundant, if, by means of *postmortem* examinations and other methods of investigation, we could be made acquainted with the facts of helminthism as they occur amongst the fish- and raw-flesh eating savage tribes. Of course any person, notwithstanding the utmost care and cleanliness, as in the cases before us, may contract a noxious parasite; nevertheless, speaking generally, it may be said that the measure of internal parasitism affecting any given class of people bears a strict relation to the degree of barbarism shown by such persons in their choice of food and drink, and in their manner of eating and drinking. This statement, if true, is not destitute of sanitary importance. Thus we may say to those interested in the matter, "Imitate the Cossacks, Burates, and Abyssinians in their fondness for raw meat, and you will be invaded by *Tæniæ*; or imitate the very similar habits of North Greenlanders in respect of fish, and you will probably enjoy the privilege of entertaining *Bothriocephali*. If you have a predilection for unfiltered waters, you are likely, sooner or later, to play the *rôle* of host to some highly irritating nematode guest; or, as so frequently happens in Iceland and Australia, you will be particularly liable to contract the so-called *Echinococcus*-disorder." Clearly it remains to be proved that shell-fish are altogether unconcerned in the matter of human helminthism; yet I quite believe that danger from this source is limited to certain mollusks living in eastern waters. In all likelihood the *Distoma crassum* is obtained by the consumption either of fish or of shell-fish. There remains, however, the consideration that its larvæ may possibly reside in minute slugs frequenting vegetables employed as salads. The rarity of fluke-disease (or, at all events, of its recognition) is tolerably conclusive against the latter view. At the Bath Meeting of the British Association, in 1864, Mr. Gwyn

Jeffreys maintained that the *Cercariæ* found in *Succinea* were the sexually immature representatives of the common liver-fluke (*Fasciola hepatica*), which, I may observe, has some twenty times been found infesting the human body. At the time in question I maintained that Mr. Jeffreys's opinion had no foundation in fact, as the negative data supplied by Moulinié and Leuckart strongly went to prove. It now turns out, from the experimental proofs recently afforded by Dr. Ernst Zeller, that the cercarian contents of *Leucochloridium* found in *Succinea* attain sexual maturity in the intestines of various insectivorous birds of the family Sylviadæ. I am indebted to Mr. Dallas for first calling my attention to this discovery. (See Ann. Nat. Hist. for Feb. 1875, p. 146; from Humbert, in Bibl. Univ., Bull. Sci. 1874, p. 366; also Zeller in S. & K. Zeitsch. für wiss. Zool. vol. xxiv. p. 564, 1874.) In connexion with any explanation of the rapid appearance of fluke-disease amongst animals in particular districts, it is especially worthy of remark that the *Cercariæ* of *Distoma macrostoma* pass into the sexually mature condition in a few days after their change of residence has been effected, whilst in less than a week's time the formation of ova has already commenced.

In conclusion, I ought perhaps to apologize for having introduced so many remarks of a practical nature into a paper otherwise purely zoological; but the supposed extreme rarity of our *Distoma crassum*, its apparently formidable character as a human guest, and the special precautions that appear to be necessary against infection have together seemed to me to be a fair excuse for sounding a note of warning to naturalists and others whose rambles or professional duties may happen to carry them to the shores of the Chinese and other eastern seas.

Similitudes of the Bones in the Enaliosauria.

By Harry Govier Seeley, F.L.S., F.G.S., Professor of Physical Geography in Bedford College, London.

[Read March 18, 1875.]

PART I.

THE RESEMBLANCES OF ICHTHYOSAURIAN BONES TO THE BONES OF OTHER ANIMALS.

§ 1. *The Mammalian Characters of* Ichthyosaurus.

A skull of *Ichthyosaurus* could not easily be changed into that of a mammal; for though Cetaceans offer close resemblance of